CHARLES DARWIN UNIVERSITY

Family Name	
Given Names	
Student Number	
Teaching Period	Semester 1, 2017

FINAL EXAMINATION	**DURATION**
SPE205 – Biomechanics 1	Reading Time: **10** minutes Writing Time: **180** minutes

INSTRUCTIONS TO CANDIDATES

EXAM CONDITIONS

You may begin writing from the commencement of the examination session. The reading time indicated above is provided as a guide only.

This is a CLOSED BOOK examination

Any non-programmable calculator is permitted

No handwritten notes are permitted

No dictionaries are permitted

ADDITIONAL AUTHORISED MATERIALS	**EXAMINATION MATERIALS TO BE SUPPLIED**
No additional printed material is permitted	1 x 20 Page Book 1 x Scrap Paper Faculty/School Multiple Choice Answer Sheet Formula Sheet/s Reference Information

Section B

Short Answer Questions

Total No of Marks for this section: 70

This section should be answered in the Answer Booklet provided.

All seven questions are made up of more than one component.

Answer all components

Marks for each question are indicated. Suggested Time allocation for Section B: 70 mins

Question 1

Table 1. The following data has been taken from an infrared data capture of a reflective marker placed on S1 of the sacrum as it is the closest landmark to a person's centre of mass (CoM). The CoM's vertical positional change has been recorded along with the capture frequency (measured in seconds) while a person performed two sit to stand repetitions from a chair. The reference point 0 m is the person's CoM while in the seated position. Using the **Central Difference Method**, first determine what the vertical velocity of the CoM's change in position, second; determine the CoM's vertical acceleration. In your answer booklet, fill in all missing values from Table 1 and show one (1) working out for the vertical velocity and one (1) for vertical acceleration as examples of your complete table. **Only replicate** the Vertical velocity and vertical acceleration columns in your answer booklet.

Frame number	Time (s)	Vertical position (m)	Vertical velocity (ms^{-1})	Vertical acceleration (ms^{-2})
1	0	0		
2	0.0625	0.1		
3	0.125	0.25		
4	0.1875	0.36		
5	0.25	0.28		
6	0.3125	0.16		
7	0.375	0		
8	0.4375	0.12		
9	0.5	0.22		
10	0.5625	0.36		
11	0.625	0.28		
12	0.6875	0.14		
13	0.75	0		

Total marks: 10

Question 2

Rowena is a rower who is trying to race a ferry from one side of a river to the other. The start and finish points are perpendicular relative to the flow of water current. The portion of the river where she is rowing is relatively straight and runs due east and the direction of the row is from north to south. The river current is 1.8 m/s. Rowena can row at a rate of 4.4 m/s. The distance between the banks is 76 m.

A: What is Rowena's resultant Velocity in m/s?

(Marks: 4)

B: If she did not account for the river current, what would Rowena's resultant displacement be from her intended destination?

(Marks: 6)

Total marks: 10

Question 3

A man with a body mass of 84 kg and lower limb segment anthropometrics of: thigh = 0.44 m (44 cm); shank = 0.38 m (38 cm); foot = 0.26 m (26 cm).

Table 1. Modified Winter's Table

Segment	Definition	Segment weight/ Total Body Weight	Centre of Mass/ Segment Length	
			Proximal	Distal
Foot	lateral malleolus/head metatarsal II	0.0145	0.500	0.475
Shank	femoral condyles/medial malleolus	0.0465	0.433	0.567
Thigh	greater trochanter / femoral condyles	0.1000	0.433	0.567
Foot and shank	femoral condyles /medial malleolus	0.0610	0.606	0.394
Total leg	greater trochanter /medial malleolus	0.1610	0.447	0.553

Using the modified Winter's Table (Table 1) determine true or false:

A: True or false, the mass of his right thigh is 7.2 kg

(Marks: 2)

B: True or false, the distance of the centre of mass of his left shank and foot from the knee is 0.215 m

(Marks: 2)

C: True or false, the mass of his whole right leg is 13.52 kg

(Marks: 2)

D: True or false, the combined mass of both feet are 2.44 kg

(Marks: 2)

E: True or false, the distance of the centre of mass of his right thigh from his ankle is 0.629 m

(Marks: 2)

Total marks: 10

Question 4

A: Golf balls are dimpled to reduce a particular type of drag. What is this drag typically known as? Discuss the effects that this drag has in balls at high, higher and extremely high velocities. **Justify your answer using biomechanical knowledge.** Diagrams can be used to help explain your reasoning.

(Marks: 4)

B: A primary goal of a sprint swimmer is to achieve maximum velocity. What is the effect of the 3 different types of drag encountered by a swimmer on their velocity? Describe strategies that can be applied to minimise these 3 types of drag. **Justify your answer using biomechanical knowledge.**

(Marks: 4)

C: A cyclist is riding with a head wind of 2.5 meters per second (m/s). Their velocity is 38 km/h. What is the velocity of the cyclist, relative to the wind? Provide your answer in m/s.

(Marks: 2)

Total marks: 10

Question 5

A: A _____ angle is the measure of a body segment with respect to an adjacent segment.

(Marks: 1)

B: An _____ angle is the measure of a body segment with respect to an external fixed line of reference.

(Marks: 1)

C: A half circle is made up of 180°, which is equivalent to _____ radians

(Marks: 1)

D: Clockwise rotational motion is _____ and anticlockwise is _____ .

(Marks: 2)

E: Angular acceleration is equal to the change in _____ _____ divided by the change in _____.

(Marks: 2)

F: The units of measure for distance or displacement of an object in rotational motion can be in _____ or _____.

(Marks: 3)

Total marks: 10

Question 6

A: Why would friction be beneficial for surfing?

(Marks: 2)

B: Why would friction **not** be beneficial for surfing?

(Marks: 2)

C: What factors affect the magnitude of friction?

(Marks: 2)

D: A wooden box is pushed across a table from your view point, right to left. Draw a free body diagram of the box. Identify (name) and indicate the direction of any forces acting on the box.

(Marks: 4)

Total marks: 10

Question 7

A: Air resistance causes the acceleration of an object to be no longer constant. What happens to:

- Trajectory path?
- Horizontal range?
- Flight height?
- Flight time?

(Marks: 4)

B: Gravitational acceleration has an effect on an object that has been thrown in the air. The vertical velocity of the ball is _____, while the gravitational acceleration effect on the ball is _____.

(Marks: 2)

C: Taylor Walker of the Adelaide Crows has marked right on the siren in the clash against their cross town AFL rivals, Port Adelaide. The point where Walker kicks from is 51 metres out from the goal line and dead in front. The flight time is 2.6 seconds and the ball sails through the middle for a total distance of 57 metres from the place of the kick. What was the horizontal velocity of the ball? Show all workings including the equation.

(Marks: 4)

Total marks: 10

This is the end of Section B. Total 70 marks

Section C

Short Essay Questions

Total Number of Marks for this section: 50

This section should be answered in the Answer Booklet provided.

Answer all five questions

Marks for each question are indicated. Suggested Time allocation for Section C: 70 mins

Question 1

A person performing a push up (Figure 2). Identify what lever system is acting at the elbow during the push up phase. Overall, there are 3 classes of levers. Provide an example of each of them within the human body and provide an example of a function in human movement of each of the systems, use free body diagrams to identify where external forces are acting on each of the levers. Furthermore, identify whether each system has or has not (or both) a mechanical advantage.

Figure 2. Push up

(Marks: 10)

Question 2

A person who weighs 78 kg is maintaining an isometric contraction while holding a 6 kg medicine ball in a position where the arms are at the side and the elbow is flexed to approximately 90°. To maintain the static position, how much force is the person producing at the biceps brachi (assume no other muscles are involved)? Use the following variables to provide the answer:

1: The perpendicular distance between the line of force developed by the biceps barachi and the centre of the elbow joint is 28 mm.

2: The length of his forearm and hand is 445 mm.

3: The distance from the elbow to the centre of mass of the medicine ball being held is 355 mm.

4: According to Winter's Table, the point of the Centre of mass of the forearm and hand position is 43% of that length.

5: The same table states that the forearm and hand is 2.2% of a person's total body weight.

(Marks: 10)

Question 3

A sled with a mass of 6.6 kg is placed on a 42° slope. The μ between the sled and slope is 0.39.

- What is the weight force of the sled?

- What is the normal force of the sled?

- What is the frictional force?

- What is the propulsive force?

- From these results, will the sled remain stationary, or will it slide?

The use of a free body diagram should be used. Show all workings and equations.

(Marks: 10)

Question 4

You are a manager of a high performance AFL support team. You are considering the purchase of wearable technology to enhance your capability to provide comprehensive data collection of the players under your conditioning schedule. You wish to make sure the technology will be beneficial for several years. Please consider and comment on:

- How would you carry out analysis of the technology for its effectiveness to your business?

- How can you predict the capacity that newer technology might be capable of in three years time?

- In addition to the purchase price, what are the costs that should be considered when using wearable technology in your consultancy?

(Marks: 10)

Question 5

Elite sprint swimmers typically use a six beat kick. Sarah Swimfast competed at the 2016 Olympic Games. She held a stroke rate of 115 strokes per minute (s/min) for the entire distance of the 100 m final and used a six beat kick the whole time. The RoM of Sarah's right knee during each kick is 61°.

1. Using degrees, what was the average angular velocity at the knee during extension phase of each kick?

2. Using radians, what was the average angular velocity at the knee during extension phase of each kick?

Show all workings.

(Marks: 10)

This is the end of Section C. Total 50 marks

Please ensure that you have written your **name** and **student number** on your **answer booklet**.
